Response of Different Phosphorus (P) Applications on Vegetative Growth of TD-1 Wheat Variety

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Abstract: The present research was conducted during the winter season of 2021-22 at Pandiani Agriculture Farm in Nasurpur City, District Tando-Allahyar, Sindh, Pakistan, with the aim of evaluating the impact of different phosphorus application methods on the vegetative growth of the TD-1 variety of wheat. The experiment utilized two phosphorus application methods, *viz* Flood Application and Broadcast Application, and the experiment was layout in Randomized Complete Block Design (RCBD) with three replications. The assessed plant growth parameters included plant height (cm), number of branches plant^{-1}, number of leaves plant^{-1}, number of roots plant^{-1}, root length (cm), and fresh biomass of the plant (g). For Flood Application, a solution of 2/L of liquid phosphorus dissolved in 100/L of water was applied per acre, while for Broadcast Application, 40 kg of Di Ammonium Phosphate (DAP) acre^{-1} was applied through irrigation. The findings demonstrated significant variations in the plant height, number of branches, number of leaves, number of roots, root length, and fresh biomass of the plant between the two phosphorus application methods. Notably, the Flood Application method resulted in substantially higher plant height, number of branches, number of leaves, number of roots, root length, and fresh biomass compared to the Broadcast Application method. These outcomes emphasize the significant influence of phosphorus application methods on wheat plant growth and productivity. The study highlights the potential benefits of employing Flood Application to enhance plant growth and biomass production. Future research endeavors could further explore the underlying mechanisms and optimize phosphorus application strategies to maximize crop yield and quality.

Keywords: Phosphorus application methods, Flood Application, Broadcast Application, wheat, growth parameters, crop productivity.

Introduction:

Wheat (Triticum aestivum L.) stands as a major global food crop, occupying a significant role among cultivated cereals. Its cultivation played a pivotal role in the green revolution, transforming nations into food surplus economies. Belonging to the poaceae family with a chromosome count of 42, wheat is a self-pollinating crop. Remarkably, wheat's production surpasses that of all other crops combined. In the year 2020, the world produced a total of 760 million tons of wheat. Notably, China, India, and Russia are the top wheat producers, contributing about 41% of the global wheat yield. The United States ranks fourth, while the European Union, as a unified entity, matches the wheat production of all nations except China.[1]

Soil fertility and crop productivity share a close relationship through three core components: bio-available soil nutrients, soil microbiota, and organic matter content. [2][3][4][5]. Phosphorus, the second most yield-limiting nutrient after nitrogen, plays critical roles in plant processes like energy storage, photosynthesis, and cell growth. Plants uptake phosphorus in forms like $H2PO4^-$ and $HPO4^{-2}$ from the soil solution. Proper application of phosphatic fertilizers, timed well and applied skillfully, significantly impacts crop yield. Nonetheless, the plant's response to fertilization can be species and variety-specific, influencing nutrient utilization.[6][7]. Introducing organic fertilizers into the soil raises the risk of xenobiotic contamination[8][9][10].

Phosphorus deficiency often restrains agricultural yields, particularly in carbonate-rich soils where phosphorus solubility is compromised. In such scenarios, achieving target crop productivity often necessitates increased fertilizer application, which can be costly.[11]. The excessive use of chemical fertilizers in recent years has been implicated in reducing soil organic content[12]. Furthermore, this practice has triggered environmental concerns such as disruptions to biological processes, soil degradation, and nutrient imbalances[13]. Studies indicate that combining organic and chemical fertilizers can boost corn and bean yields and quality, enabling reduced reliance on chemical fertilizers. This approach enhances soil health and overall sustainability[14].

Material and Methods:

The present research was conducted at Pandiani Agriculture Farm, Nasarpur City, District Tando-Allahyar, Sindh, Pakistan during the winter of 2021-22. The TD-1 variety was sown in the field. Two different phosphorus application methods, *viz* Flood Application and Broadcast Application, were utilized. The experiment was laid out in a Randomized Complete Block Design (RCBD) with Three replications. Various parameters were observed, including plant height (cm), number of branches plant^{-1}, number of leaves per plant, number of roots plant^{-1}, root length (cm), and fresh biomass of the plant (g), respectively. For flood application, a mixture of 2/L (liquid phosphorus) dissolved in 100/L of water should be applied per acre. In the case of broadcast application, 40 kg of DAP (Di Ammonium Phosphate) per acre was applied through irrigation. The Data was analyzed by using statistical analysis software Statistix 8.1 (Statistix, 2008). In order to compare treatment superiority and performance, the least significant variance (LSD) assessment was practical at (P<0.05) possibility equal.

Results and Discussion

Plant Height: primarily reflects the effect of the cultivar or the plant's reaction to management conditions. In this study, the height of wheat plants was measured to assess the impact of different phosphorus application methods. The results indicated a significant effect (P< 0.05) of the various phosphorus application methods on plant height. (Table-1) shows in plant height suggest that the application of phosphorus influenced the growth and development of the wheat plants. Specifically, when comparing the two application methods, the Flood Application method resulted in an maximum plant height of 50.8 cm, while the minimum result was record Broadcast Application method an plant height of 44.45 cm. The significant effect of phosphorus application on plant height, with the Flood Application method resulting in taller plants compared to the Broadcast Application method, highlights the importance of appropriate nutrient management strategies for optimizing plant growth. These findings emphasize the need for considering phosphorus application methods as a crucial factor in enhancing crop development and yield. It's important to note that the significance level (P-value) of 0.05 indicates that the observed differences in plant height between the phosphorus application methods are unlikely due to random chance, but rather attributed to the different treatments applied.

Number of Branches Plant^{-1}: primarily reflects the effect of the cultivar or the plant's reaction to management conditions. In this study, the branches of wheat plants was measured to assess the impact of different phosphorus application methods.

The results indicated a significant effect (P<0.05) of the various phosphorus application methods on number of branches plant^{-1}. (Table-1) shows number of branches plant^{-1} suggest that the application of phosphorus influenced the growth and development of the wheat plants.

Specifically, when comparing the two application methods, the Flood Application method resulted in an maximum number of branches plant^{-1} (8.00) while the minimum result was record Broadcast Application method an number of branches plant^{-1} (3.00).

The significant effect of phosphorus application on number of branches plant^{-1}, with the Flood Application method resulting in maximum branches compared to the Broadcast Application method, highlights the importance of appropriate nutrient management strategies for optimizing plant growth.

These findings emphasize the need for considering phosphorus application methods as a crucial factor in enhancing crop development and yield.

It's important to note that the significance level (P-value) of 0.05 indicates that the observed differences in number of branches plant^{-1} between the phosphorus application methods are unlikely due to random chance, but rather attributed to the different treatments applied.

Number of Leaves Plant^{-1}: primarily reflects the effect of the cultivar or the plant's reaction to management conditions. In this study, the Leaves of wheat plants was measured to assess the impact of different phosphorus application methods.

The results indicated a significant effect (P<0.05) of the various phosphorus application methods on number of Leaves plant^{-1}. (Table-1) shows number of Leaves plant^{-1} suggest that the application of phosphorus influenced the growth and development of the wheat plants.

Specifically, when comparing the two application methods, the Flood Application method resulted in an maximum number of Leaves plant^{-1} (18.00) while the minimum result was record Broadcast Application method an number of Leaves plant^{-1} (12.00).

The significant effect of phosphorus application on number of Leaves plant^{-1}, with the Flood

Application method resulting in maximum Leaves compared to the Broadcast Application method, highlights the importance of appropriate nutrient management strategies for optimizing plant growth.

These findings emphasize the need for considering phosphorus application methods as a crucial factor in enhancing crop development and yield.

It's important to note that the significance level (P-value) of 0.05 indicates that the observed differences in number of Leaves plant^{-1} between the phosphorus application methods are unlikely due to random chance, but rather attributed to the different treatments applied.

Number of Roots Plant^{-1}: primarily reflects the effect of the cultivar or the plant's reaction to management conditions. In this study, the Roots of wheat plants was measured to assess the impact of different phosphorus application methods.

The results indicated a significant effect ($P<0.05$) of the various phosphorus application methods on number of Roots plant^{-1}. (Table-1) shows number of Roots plant^{-1} suggest that the application of phosphorus influenced the growth and development of the wheat plants.

Specifically, when comparing the two application methods, the Flood Application method resulted in an maximum number of Roots plant^{-1} (26.00) while the minimum result was record Broadcast Application method an number of Roots plant^{-1} (18.00).

The significant effect of phosphorus application on number of Roots plant^{-1}, with the Flood Application method resulting in maximum Roots compared to the Broadcast Application method, highlights the importance of appropriate nutrient management strategies for optimizing plant growth.These findings emphasize the need for considering phosphorus application methods as a crucial factor in enhancing crop development and yield.

It's important to note that the significance level (P-value) of 0.05 indicates that the observed differences in number of Roots plant^{-1} between the phosphorus application methods are unlikely due to random chance, but rather attributed to the different treatments applied.

Root Length (cm): primarily reflects the effect of the cultivar or the plant's reaction to management conditions. In this study, the Root length of wheat plants was measured to assess the impact of different phosphorus application methods.

The results indicated a significant effect ($P<0.05$) of the various phosphorus application methods on root length. (Table-1) shows root length (cm)suggest that the application of phosphorus influenced the growth and development of the wheat plants.

Specifically, when comparing the two application methods, the Flood Application method resulted in an maximum root length (15.50cm)while the minimum result was record Broadcast Application method an root length (cm)(11.43).

The significant effect of phosphorus application on root length (cm), with the Flood Application method resulting in maximum Roots compared to the Broadcast Application method, highlights the importance of appropriate nutrient management strategies for optimizing plant growth.These findings emphasize the need for considering phosphorus application methods as a crucial factor in enhancing crop development and yield.

It's important to note that the significance level (P-value) of 0.05 indicates that the observed differences in root length (cm) between the phosphorus application methods are unlikely due to random chance, but rather attributed to the different treatments applied.

Fresh Biomass of Plant (g): primarily reflects the effect of the cultivar or the plant's reaction to management conditions. In this study, the Fresh Biomass of Plant (g) of wheat plants was measured to assess the impact of different phosphorus application methods.

The results indicated a significant effect ($P<0.05$) of the various phosphorus application methods on Fresh Biomass of Plant (g). (Table-1) shows Fresh Biomass of Plant (g)suggest that the application of phosphorus influenced the growth and development of the wheat plants.

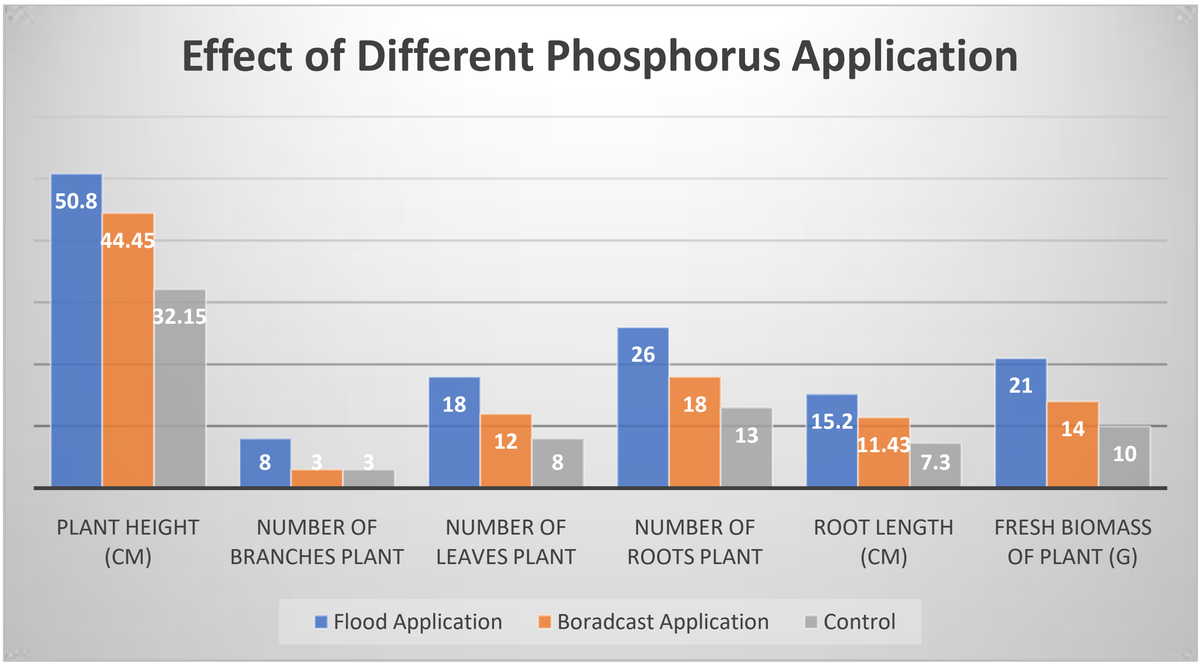
Specifically, when comparing the two application methods, the Flood Application method resulted in an maximum Fresh Biomass of Plant (21 g)while the minimum result was record Broadcast Application method an Fresh Biomass of Plant (14g).

The significant effect of phosphorus application on Fresh Biomass of Plant (g), with the Flood Application method resulting in maximum Biomass of plant compared to the Broadcast Application method, highlights the importance of appropriate nutrient management strategies for optimizing plant growth. These findings emphasize the need for considering phosphorus application methods as a crucial factor in enhancing crop development and yield.

It's important to note that the significance level (P-value) of 0.05 indicates that the observed differences in

Fresh Biomass of Plant (g) between the phosphorus application methods are unlikely due to random chance, but rather attributed to the different treatments applied.

Table-1: Plant Height (cm), Number of Branches Plant^{-1}, Number of Leaves Plant^{-1}, Number of Roots^{-1}, Root Length (cm), Fresh Biomass of Plant (g) as Affected by Different Phosphorous Application.



Conclusion:

The results of the study demonstrated significant differences in plant height, number of branches, number of leaves, number of roots, root length, and fresh biomass of the plant between the two phosphorus application methods. The Flood Application method exhibited superior performance, leading to taller plants with more branches, leaves, roots, longer root length, and greater fresh biomass compared to the Broadcast Application method.

These findings highlight the importance of phosphorus application methods in influencing wheat plant growth and development. The use of Flood Application can significantly enhance the desired growth parameters and biomass production of the TD-1 variety. This suggests that considering appropriate phosphorus application strategies can contribute to improving crop productivity and yield.

The research outcomes provide valuable insights for farmers, agronomists, and researchers in making informed decisions regarding phosphorus management practices in wheat cultivation. The findings support the adoption of Flood Application as a recommended method for achieving optimal growth and maximizing the potential of the TD-1 variety.

Further research is recommended to delve deeper into the underlying mechanisms of phosphorus uptake and utilization by wheat plants, as well as to explore other potential phosphorus application strategies. Such investigations can contribute to developing precise and efficient nutrient management practices, ultimately enhancing the sustainability and profitability of wheat production.

In summary, the study highlights the significance of phosphorus application methods in influencing wheat plant growth parameters, with Flood Application demonstrating superior performance. These findings underscore the need for implementing appropriate phosphorus management strategies to achieve improved crop growth and productivity.

Suggestions for Further Research:

Based on the findings of this study, several suggestions for further research can be proposed:

Nutrient Interaction: Investigate the interaction between phosphorus application methods and other nutrients to understand their combined effects on wheat growth and development. Explore the synergistic or antagonistic relationships between phosphorus and other essential elements to optimize nutrient management practices.

Long-Term Effects: Conduct long-term studies to assess the sustained impact of different phosphorus application methods on wheat crop performance. Explore the effects on not only immediate growth parameters but also on yield, quality attributes, and overall sustainability of wheat production systems.

Optimization of Application Rates: Further investigate the optimal application rates of phosphorus for Flood Application and Broadcast Application methods. Determine the threshold levels and fine-tune the application rates to achieve the desired growth parameters and maximize wheat yield.

Economic Analysis: Perform an economic analysis to assess the cost-effectiveness and profitability of different phosphorus application methods. Evaluate the input costs, labor requirements, and potential benefits to provide practical recommendations for farmers and decision-makers.

Mechanisms of Phosphorus Uptake: Explore the mechanisms underlying phosphorus uptake and utilization by wheat plants under different application methods. Investigate the molecular and physiological processes involved in phosphorus acquisition and assimilation to enhance our understanding of plant-nutrient interactions.

Field Validation: Validate the findings of this study in different locations, soil types, and wheat varieties to assess the generalizability and robustness of the results. Consider conducting on-farm trials to bridge the gap between research outcomes and practical application.

These suggestions aim to expand the knowledge base surrounding phosphorus application methods in wheat cultivation and provide insights for improved nutrient management practices. Addressing these research areas will contribute to enhancing crop productivity, nutrient use efficiency, and sustainability in wheat production systems.

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